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CLAIMS

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[Claim(s)]

[Claim 1] The non-sintering nickel pole for closed mold alkaline batteries which is a non-sintering nickel pole for closed mold alkaline batteries which consists of the 1st active material which covered nickel hydroxide with oxy-cobalt hydroxide, and the 2nd active material which covered oxy-nickel hydroxide with oxy-cobalt hydroxide, and is characterized by carrying out mixed use of the 1st active material and 2nd active material by the weight ratio of 90:10-60:40.

[Claim 2] The non-sintering nickel pole for closed mold alkaline batteries which is a non-sintering nickel pole for closed mold alkaline batteries which consists of the 1st active material which covered nickel hydroxide with oxy-cobalt hydroxide, and the 2nd active material which covered oxy-nickel hydroxide with oxy-cobalt hydroxide, and is characterized by carrying out mixed use of the 1st active material and 2nd active material by the weight ratio of 80:20-70:30.

[Claim 3] The non-sintering nickel pole for closed mold alkaline batteries according to claim 1 or 2 characterized by adding oxy-cobalt hydroxide at 1.0 - 10.0% of the weight of a rate by atomic conversion of cobalt to nickel hydroxide in the 1st active material of the above.

[Claim 4] The non-sintering nickel pole for closed mold alkaline batteries according to claim 1 or 2 characterized by adding oxy-cobalt hydroxide at 1.0 - 10.0% of the weight of a rate by atomic conversion of cobalt to oxy-nickel hydroxide in the 2nd active material of the above.

[Claim 5] The non-sintering nickel pole for closed mold alkaline batteries according to claim 1 or 2 characterized by containing at least one sort of elements chosen from the group which nickel hydroxide becomes from zinc, magnesium, calcium, manganese, aluminum, cadmium, an yttrium, cobalt, a bismuth, a lanthanum, an ytterbium, an erbium, a gadolinium, and a cerium in the 1st active material of the above.

[Claim 6] The non-sintering nickel pole for closed mold alkaline batteries according to claim 1 or 2 characterized by containing at least one sort of elements chosen from the group which oxy-nickel hydroxide becomes from zinc, magnesium, calcium, manganese, aluminum, cadmium, an yttrium, cobalt, a bismuth, a lanthanum, an ytterbium, an erbium, a gadolinium, and a cerium in the 2nd active material of the above.

[Claim 7] A claim 1 or the closed mold alkaline battery using the non-sintering nickel pole according to claim 2.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which this invention belongs] With respect to the cell which used the non-sintering nickel pole for closed mold alkaline batteries, and its nickel pole, this invention cuts down electric discharge reserve in detail, and relates to improvement of the active material aiming at offering the nickel pole for closed mold alkaline batteries which moreover excelled [ high capacity ] in the high-rate-discharge property.

[0002]

[The conventional \*\*\*\*\*] Conventionally, the sintering formula nickel pole which makes an active material (nickel hydroxide) come to sink into the sintered carrier which the pierced steel plank etc. was made to sinter nickel powder, and obtained it as a positive electrode of closed mold alkaline batteries, such as a nickel-hydrogen battery and a Ni-Cd battery, is known well.

[0003] In order to make [ many ] the fill of an active material on a sintering formula nickel pole, it is necessary to use a sintered carrier with large porosity. However, since the combination between the nickel particles by sintering is weak, if the porosity of a sintered carrier is enlarged, a nickel particle will become easy to drop out of a sintering formula substrate. Therefore, the porosity of a sintered carrier cannot be practically made larger than 80%. So, there is a problem that there are few active material fills in a sintering nickel pole. Moreover, generally, 10 micrometers or less and since the aperture of the sintered compact of nickel powder is small, it also has the problem that restoration to the sintered carrier of an active material must be performed by the solution sinking-in method which needs to repeat a complicated sinking-in process several times.

[0004] Since it is such, the non-sintering nickel pole represented on the paste formula nickel pole is proposed recently. A paste formula nickel pole is produced by filling up a substrate with large porosity with the kneading object (paste) of an active material (nickel hydroxide) and binders (methyl-cellulose solution etc.). Since a substrate with large porosity can be used (the substrate of 95% or more of porosity can be used), while being able to make [ many ] the fill of an active material, the restoration to the substrate of an active material is easy on the paste formula nickel pole.

[0005] However, if a substrate with large porosity is used to make [ many ] the fill of an active material on a paste formula nickel pole, the current collection nature of a substrate will become bad and an active material utilization factor will fall.

[0006] Then, adding cobalt hydroxide  $[\text{Co}(\text{OH})_2]$  as an electric conduction agent to nickel hydroxide is proposed to raise the active material utilization factor of a paste formula nickel pole (refer to JP,61-49374,A). Cobalt divalent cobalt hydroxide oxidizes to cobalt trivalent oxy-cobalt hydroxide (beta- $\text{CoOOH}$ ) by first-time charge, and this forms a conductive network and raises an active material utilization factor.

[0007] By the way, even if it enlarges negative-electrode capacity compared with positive-electrode capacity and the full charge of the positive electrode is carried out, the nickel-hydrogen battery and the Ni-Cd battery are designed so that a non-energized part (the geometric capacity of this non-energized part is hereafter called "charge reserve".) may exist in a negative electrode. This charge reserve In the case of (cadmium pole, by making the oxygen gas ( $2\text{OH}^- \rightarrow \frac{1}{2}\text{O}_2 + \text{H}_2\text{O} + 2\text{e}^-$ ) which occurs from a positive electrode at the time of the charge last stage and overcharge absorb by the negative electrode Case:  $2\text{MH} + \frac{1}{2}\text{O}_2 \rightarrow 2\text{M} + \text{H}_2\text{O}$ ) of a :  $\text{Cd} + \frac{1}{2}\text{O}_2 + \text{H}_2\text{O} \rightarrow \text{Cd}(\text{OH})_2$ ; hydrogen pole, Although there are some which are prepared in order to suppress elevation of the internal pressure of a closed mold cell, it also has the work which suppresses the fall of the service capacity especially based on decline in the active material utilization factor of the negative electrode at the time of a high rate discharge.

[0008] The oxidization to the oxy-cobalt hydroxide at the time of the charge in the above-mentioned conventional paste formula nickel pole from cobalt hydroxide is irreversible. That is, it is not returned at the time of electric discharge, but the oxy-cobalt hydroxide generated at the time of charge is still oxy-cobalt hydroxide. Therefore, quantity of electricity which the oxidization to oxy-cobalt hydroxide from cobalt hydroxide took will be stored in a negative electrode as potential electric discharge quantity of electricity ("electric discharge reserve" is called hereafter.). Moreover, a charge-

and-discharge reaction is not a perfect reversible reaction, either. That is, the oxy-nickel hydroxide generated by charge is not completely returned to nickel hydroxide by electric discharge. Therefore, quantity of electricity equal to the difference of charge quantity of electricity which oxidization of a positive active material took in first-time charge and discharge, and electric discharge quantity of electricity which reduction took is stored in a negative electrode as electric discharge reserve.

[0009] Since the rate of the active material which can actually be used became small when the rate of the electric discharge reserve occupied to the active material with which the cell was filled up is large, there was a problem that the capacity of a cell fell. Then, it is considered to be effective to high-capacity-izing of a cell to cut down electric discharge reserve.

[0010] However, since there is work which suppresses the cell-voltage fall by elevation of negative-electrode potential in the electric discharge last stage at the time of a high rate discharge in electric discharge reserve, even if there are too few rates of the electric discharge reserve occupied in negative-electrode capacity, the service capacity in a high rate discharge falls. Therefore, in order for the service capacity in a high rate discharge to obtain the non-sintering nickel pole which gives a large alkaline battery, it is necessary to design the amount of irreversible reaction of a positive electrode so that electric discharge reserve may become proper.

[0011] It is equal to making proper the difference of charge quantity of electricity in first-time charge and discharge, and electric discharge quantity of electricity to make electric discharge reserve proper. As a positive-electrode electric conduction agent, it replaces with cobalt hydroxide, and if the oxy-cobalt hydroxide proposed by JP,8-24041,B is used, since neither oxidization nor reduction is carried out by charge and discharge, oxy-cobalt hydroxide can make zero (0) electric discharge reserve which originates in a positive-electrode electric conduction agent, and is generated.

[0012] Moreover, when the active material mixture containing the nickel hydroxide powder, oxy-nickel hydroxide powder, and cobalt powder which are proposed by JP,60-254564,B is used, the electric discharge reserve for quantity of electricity which oxidization of cobalt takes can be reduced by adding oxy-nickel hydroxide.

[0013] However, since electric discharge reserve of a negative electrode is the total quantity of the electric discharge reserve which originates in the electric discharge reserve and the positive active material which originate in a positive-electrode electric conduction agent, and are generated, and is generated, if it does not decrease the electric discharge reserve which originates in a positive active material and is generated, either, it cannot make electric discharge reserve proper.

[0014]

[Problem(s) to be Solved by the Invention] Therefore, it aims at offering the non-sintering nickel pole which makes the suitable electric discharge reserve for a negative electrode which enables this invention to produce a closed mold alkaline battery with the large service capacity in a high rate discharge generate.

[0015]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the non-sintering nickel pole for closed mold alkaline batteries concerning this invention is a non-sintering nickel pole for alkaline batteries which consists of the 1st active material which covered nickel hydroxide with oxy-cobalt hydroxide, and the 2nd active material which covered oxy-nickel hydroxide with oxy-cobalt hydroxide, and is characterized by carrying out mixed use of the 1st active material and 2nd active material by the weight ratio of 90:10-60:40.

[0016] Here, when the weight ratio of the 2nd active material which consists of oxy-nickel hydroxide is less than 10 % of the weight, the amount of irreversible reaction of the positive electrode in a charge-and-discharge reaction increases, and electric discharge reserve of a negative electrode becomes excessive. Consequently, since the rate of the active material which can actually be used among the active materials with which the cell was filled up falls, the fall of capacity arises. On the other hand, when the weight ratio of the 2nd active material which consists of oxy-nickel hydroxide exceeds 40 % of the weight, the reversible reaction in a charge-and-discharge reaction increases, and electric discharge reserve becomes [ too little ]. Consequently, it becomes impossible to fully suppress elevation of the electric discharge last stage and the negative-electrode potential at the time of a high rate discharge, and the service capacity of the cell at the time of a high rate discharge falls. Therefore, mixed use of the 1st active material and 2nd active material is carried out by the weight ratio of 90:10-60:40.

[0017] Furthermore, it enables a cycle property to improve further by carrying out mixed use of the 1st active material and 2nd active material by the weight ratio of 80:20-70:30.

[0018] Moreover, you may make at least one sort of elements chosen as the nickel hydroxide of the 1st active material as a positive active material and/, or the 2nd active material and/, or oxy-nickel hydroxide from zinc, magnesium, calcium, manganese, aluminum, cadmium, an yttrium, cobalt, a bismuth, a lanthanum, the ytterbium, the erbium, the gadolinium, and the cerium dissolve. Bulking of a positive active material can be suppressed by making these elements dissolve.

[0019] Here, the oxy-nickel hydroxide used for the 2nd active material prepares nickel hydroxide, and it can produce it

easily by carrying out being predetermined-time (usually for 3 - 60 minutes) immersed, agitating in the solution which added alkali, such as a sodium hydroxide, in hydrogen peroxide solution and hypochlorite solution. The reason for adding the above-mentioned alkali is for raising pH of solution and promoting the oxidization to oxy-nickel hydroxide. [0020] The oxy-cobalt hydroxide which covered the nickel hydroxide of the 1st active material and/, or the 2nd active material and/, or oxy-nickel hydroxide is 1.0 - 10.0 % of the weight to nickel hydroxide powder and oxy-nickel hydroxide powder by the ratio in atomic conversion of cobalt. Since an active material utilization factor falls when the amount of the said covering is less than 1.0 % of the weight, and in order that [ when this addition exceeds 10.0 % of the weight, ] the fill of a nickel hydroxide may decrease, when it is any, service capacity falls.

[0021] The above-mentioned oxy-cobalt hydroxide which covers an active material can produce cobalt hydroxide easily by carrying out being predetermined-time immersed and oxidizing in the solution which added alkali, such as a sodium hydroxide, in the oxidizer solution, agitating. In addition, weak-acid-ized agents, such as a potassium peroxodisulfate, can also be used for oxidization of cobalt hydroxide outside oxidants, such as a hydrogen peroxide and a hypochlorite.

[0022] Oxidization to the oxy-nickel hydroxide of nickel hydroxide and oxidization to the oxy-cobalt hydroxide of cobalt hydroxide may be performed separately, respectively, and may use an oxidant and may be performed at once.

[0023] With the application of this invention, as a suitable non-sintering nickel pole for closed mold alkaline batteries, the paste which contains the 1st active material of the above and the 2nd active material in a conductive axis is applied, and the paste formula nickel pole which it comes to dry is mentioned. As an example of the conductive axis at this time, a nickel foam, a felt-like metal-fiber porous body, and a punching metal are mentioned. Outside this, this invention applies the tube-like nickel pole filled up with an active material into a tube-like metal conductor, the pocket-like nickel pole filled up with an active material into a pocket-like metal conductor, and an active material to the nickel pole for button type cells which carries out pressing with a mesh-like metal conductor and is suitable.

[0024] As an example of a suitable closed mold alkaline battery, a nickel-hydrogen battery (negative electrode : hydrogen storing metal alloy electrode), a Ni-Cd battery (negative electrode : cadmium electrode), and a zinc nickel oxide battery (negative electrode : zinc electrode) are mentioned, using this invention electrode as a positive electrode.

[0025] In this invention electrode, since the nickel hydroxide and oxy-nickel hydroxide as a positive active material are covered with oxy-cobalt hydroxide as an electric conduction agent, respectively, when this is used as a positive electrode of a closed mold alkaline battery, electric discharge reserve of a negative electrode can be freely controlled by the mixed ratio of the 1st active material and the 2nd active material, and let the amount of electric discharge reserve be a proper thing with it. For this reason, the closed mold alkaline battery which used this invention electrode has the large service capacity in a high rate discharge.

[0026]

[Embodiments of the Invention] It is possible to change this invention suitably in the range which is not limited to the following example at all and does not change the summary, and to carry out hereafter, although this invention is further explained to a detail based on an example.

[Experiment 1] In this experiment 1, in order to investigate the predominance of this invention electrode, comparison with an electrode was performed conventionally.

(Example 1)

100g of nickel hydroxide is dropped in 1000ml of solution of 13.1g of <production of 1st active material> cobalt sulfates, and it is dropped, agitating one mol [l. ] sodium-hydroxide solution, and pH of liquid is adjusted to 11. Then, churning mixture was carried out for 1 hour, and rinsing and the nickel hydroxide particle powder which carried out the vacuum drying and covered the front face with cobalt hydroxide were produced the \*\* exception. In addition, when pH of liquid is supervised in a pH meter (glass electrode with automatic focusing) during above-mentioned being immersed and pH of liquid falls, suitably, the above-mentioned sodium-hydroxide solution is dropped and pH is held to 11.

[0027] In order to change the above-mentioned cobalt hydroxide to oxy-cobalt hydroxide, it processes in the following procedure. First, it is immersed for 10 minutes, agitating 100g of nickel hydroxide particle powder which covered the front face with the above-mentioned cobalt hydroxide in a 50ml [ of sodium-hypochlorite solution ] mixed-water solution 12% of the weight with 1000ml of sodium hydroxides 30% of the weight. Then, the \*\* exception, it rinsed, and it dried and the oxy-nickel hydroxide particle powder (the 1st active material) which had the front face covered with oxy-cobalt hydroxide was obtained.

[0028] In this 1st active material, to nickel hydroxide, oxy-cobalt hydroxide is atomic conversion of cobalt, and is added 5% of the weight. In addition, the content of this oxy-cobalt hydroxide is calculated as follows.

[0029] Content (weight % by atomic conversion of cobalt) =  $100 \times \frac{\text{weight of cobalt sulfate} \times (\text{atomic weight of cobalt atom})}{(\text{molecular weight of cobalt sulfate})}$  / of oxy-cobalt hydroxide (weight of nickel hydroxide)

In production of the 1st active material of the <production of 2nd active material> above, it was immersed for 10

minutes, agitating 100g of particle powder which consists of nickel hydroxide covered with cobalt hydroxide 30% of the weight in 1000ml of sodium hydroxides, and a 1000ml [ of 12 % of the weight sodium-hypochlorite solution ] mixed-water solution. Then, the \*\* exception, it rinsed and dried and the oxy-nickel hydroxide particle powder (the 2nd 2nd active material) which covered the front face with oxy-cobalt hydroxide was produced. Cobalt hydroxide and nickel hydroxide have oxidized to oxy-cobalt hydroxide and oxy-nickel hydroxide, respectively in the case of the above-mentioned immersing processing.

[0030] In this 2nd active material, to oxy-nickel hydroxide, oxy-cobalt hydroxide is atomic conversion of cobalt, and is added 5% of the weight. In addition, the content of this oxy-cobalt hydroxide is calculated as follows.

[0031] Content (weight % by atomic conversion of cobalt) =  $100 \times \frac{(\text{weight of cobalt sulfate}) \times (\text{atomic weight of cobalt atom})}{(\text{molecular weight of cobalt sulfate})}$  / of oxy-cobalt hydroxide (weight of oxy-nickel hydroxide)

The 1st active material obtained with the <production of non-sintering nickel pole> above <production of the 1st active material> and the 2nd active material obtained by doing in this way were mixed by the weight ratio 80:20.

[0032] This mixed particle 100 weight section and the 1-% of the weight methyl-cellulose solution 20 weight section as a binder were kneaded, the paste was prepared, and it was filled up with this paste in the pore of the nickel foam (95% of porosity, 200 micrometers of average apertures) which is a conductive base, and it dried, and pressing was carried out and the non-sintering nickel pole was produced.

<production of a closed mold alkaline battery> -- the closed mold alkaline battery (geometric capacity : about 1000 mAh(s)) A1 of AA size was produced using this non-sintering nickel pole (positive electrode), a polyamide nonwoven fabric (separator), 30-% of the weight potassium-hydroxide solution (electrolytic solution), the metal cell can, the metal cell lid, etc. The ratio of positive-electrode capacity and negative-electrode capacity was set to 1:2. Also in the following examples and examples of comparison, all the ratios of positive-electrode capacity and negative-electrode capacity were set to 1:2.

(Example 2) The ammonium-sulfate salt was added in the solution which mixed the nickel sulfate and the zinc sulfate by the weight ratio 99.5:0.5, and nickel and zincky ammine complex ion were formed in it. This liquid was dropped at sodium-hydroxide solution, and the nickel hydroxide to which zinc dissolved 0.5% of the weight was produced. The 1st active material was obtained by the same method as an example 1 using 100g of this nickel hydroxide. The 2nd active material used the same thing as the above-mentioned example 1. Except that the 1st active materials differed, the non-sintering nickel pole and the closed mold alkaline battery A2 were obtained like the example 1.

(Example 3) It replaced with 1000ml 12% of the weight at sodium-hypochlorite solution, and the non-sintering nickel pole and the closed mold alkaline battery A3 were obtained like the example 1 except having used 1000ml of hydrogen peroxide solution 31% of the weight.

(Example 1 of comparison) The nickel hydroxide 100 weight section, the cobalt hydroxide 7.9 weight section (they are 5 weight sections by cobalt atom conversion), and the 1-% of the weight methyl-cellulose solution 20 weight section as a binder were kneaded, and the paste was adjusted. Into the pore of a nickel foam (95% of porosity, 200 micrometers of average apertures), it filled up and dried, pressing of this paste was carried out, and the non-sintering nickel pole was produced. This non-sintering nickel pole is the conventional electrode of the indication to JP,61-49374,A. Closed mold alkaline battery X was produced like the example 1 except having used this non-sintering nickel pole as a positive electrode.

(Example 2 of comparison) 100g of nickel hydroxide and 6.3g of 1 cobalt oxide were supplied to 1000ml of potassium-hydroxide solution of specific gravity 1.25, 135g was supplied, it mixed for 1 hour, the potassium peroxodisulfate (K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>) was dried after filtration / rinsing, and the complex particle which comes to cover the particle front face of nickel hydroxide with oxy-cobalt hydroxide was produced. This complex particle 100 weight section and the 1-% of the weight methyl-cellulose solution 20 weight section as a binder were kneaded, the paste was adjusted, and it was filled up with this paste in the pore of a nickel foam (95% of porosity, 200 micrometers of average apertures), and it dried, and pressing was carried out and the non-sintering nickel pole was produced. This non-sintering nickel pole is the conventional electrode of the indication to JP,8-24041,B. Closed mold alkaline battery Y was produced like the example 1 except having used this non-sintering nickel pole as a positive electrode.

(Example 3 of comparison) After being immersed for 10 minutes, agitating 100g of nickel hydroxide in a 1000ml [ of sodium-hypochlorite solution ] mixed-water solution 12% of the weight with 1000ml of sodium hydroxides 30% of the weight, the \*\* exception, it rinsed, and it dried and oxy-nickel hydroxide was produced. Thus, into the mixture which mixed the obtained oxy-nickel hydroxide and nickel hydroxide by 10:90, 5 weight sections, in addition active material mixture were obtained for the cobalt metal. This active material mixture 100 weight section and the 1-% of the weight methyl-cellulose solution 20 weight section as a binder were kneaded, the paste was prepared, into the pore of a nickel foam (95% of porosity, 200 micrometers of average apertures), it filled up and dried, pressing of this paste was carried out, and the non-sintering nickel pole was produced. This non-sintering nickel pole is the conventional electrode of the indication to JP,60-254564,A. Closed mold alkaline battery Z was produced like the example 1 except having used this

non-sintering nickel pole as a positive electrode.

After charging by 0.1C at 25 degrees C about <comparison of each cell property> each cell for 16 hours, the service capacity C1 (mAh) of 9 cycle deed and 9 cycle eye of each cell was calculated for the charge and discharge which make 1 cycle the process which discharges to 1.0V by 1C at 25 degrees C. Subsequently, after charging each cell by 0.1C at 25 degrees C for 16 hours, it discharged to 1.0V by 4C at 25 degrees C, and the service capacity C2 (mAh) of 10 cycle eye of each cell was calculated. About each cell, ratio [ of the service capacity C2 to service capacity C1 ] P (%) was computed. A ratio P is an index which shows the quality of the high-rate-discharge property of each cell, and its high-rate-discharge property is so good that this value is large. A result is shown in Table 1. The service capacity of 9 cycle eye of each cell in Table 1 is the relative index which set service capacity of 9 cycle eye of a cell A1 to 100.

[0033]

[Table 1]

電池	9サイクル目の 放電容量 (C1)	比率P(%)
A1	100	89
A2	104	91
A3	100	89
X	90	69
Y	92	70
Z	92	70

[0034] As shown in Table 1, compared with Cells X, Y, and Z, cells A1-A3 have the large service capacity of 9 cycle eye, and, moreover, its ratio P is large. This result shows that a closed mold alkaline battery with the large service capacity in a high rate discharge is obtained compared with the case where an electrode is conventionally used by using this invention electrode.

[Experiment 2] In this experiment 2, the kind of alloying element mixed to the 1st active material and the 2nd active material was replaced with, and the electrode characteristic and the cell property were compared.

It replaces with the zinc sulfate in the example 2 of the above-mentioned experiment 1. (example 4: -- when changing the alloying element to the 1st active material) Magnesium (Mg), calcium (calcium), manganese (Mn), aluminum (aluminum), Cadmium (Cd), an yttrium (Y), cobalt (Co), a bismuth (Bi), A non-sintering nickel pole and alkaline batteries B1-B13 were obtained like the example 2 except having used the sulfate of a lanthanum (La), an ytterbium (Yb), an erbium (Er), a gadolinium (Gd), and a cerium (Ce).

(example 5: -- when changing the alloying element to the 2nd active material) the ammonium-sulfate salt was added in the solution which mixed the nickel sulfate and the zinc sulfate by the weight ratio 99.5:0.5, and nickel and zincky ammine complex ion were formed in it This liquid was dropped at sodium-hydroxide solution, and the nickel hydroxide to which zinc dissolved 0.5% of the weight was produced. The 1st and 2nd active materials were obtained by the same method as the above-mentioned example 1 using 100g of this nickel hydroxide. Except that active materials differed, the non-sintering nickel pole and the closed mold alkaline battery B14 were obtained like the example 1.

(Example 6) It replaced with the zinc sulfate in the above-mentioned example 5, and the non-sintering nickel pole and the alkaline battery B15 were obtained like the above-mentioned example 5 except having used magnesium sulfate.

(Example 7) In the above-mentioned example 5, the non-sintering nickel pole and the closed mold alkaline battery B16 were obtained like the above-mentioned example 5 except having produced the nickel hydroxide to which the nickel sulfate, the zinc sulfate, and the cobalt sulfate were mixed by the weight ratio 99:0.5:0.5, and zinc and cobalt dissolved by a unit of 0.5% of the weight.

[0035] These cells were prepared and the cell property was compared like the aforementioned experiment 1. This result is shown in Table 2.

[0036]

[Table 2]



電池	第1の活物質 への添加元素	第2の活物質 への添加元素	9サイクル目の 放電容量(C1)	比率P (%)
A1	—	—	100	89
A2	Zn	—	106	91
B1	Mg	—	105	91
B2	Ca	—	105	91
B3	Mn	—	106	91
B4	Al	—	105	91
B5	Cd	—	105	91
B6	Y	—	106	91
B7	Co	—	105	91
B8	Bi	—	106	91
B9	La	—	105	91
B10	Yb	—	105	91
B11	Er	—	105	91
B12	Gd	—	105	91
B13	Ce	—	105	91
B14	Zn	Zn	108	92
B15	Mg	Mg	108	92
B16	Zn+Co	Zn+Co	110	93

[0037] It is understood rather than the cell A1 which does not have an alloying element in the 1st active material and the 2nd active material from this result that the cell B16 which added two or more alloying elements to the cells A1, B1-B13 which added the alloying element to the 1st active material, the cells B14 and B15 which added the alloying element to the 1st and 2nd active materials, the 1st, and 2nd active materials further has the outstanding cell property. [experiment 3] -- this experiment 3 -- the mixing ratio of nickel hydroxide and oxy-nickel hydroxide -- a rate, i.e., the mixing ratio of the 1st active material and the 2nd active material, -- the relation of a rate and the high-rate-discharge property of a cell was investigated

[0038] First, the mixing ratio of the nickel hydroxide (the 1st active material) covered with oxy-cobalt hydroxide and the oxy-nickel hydroxide (the 2nd active material) covered with oxy-cobalt hydroxide was replaced with the weight ratio 80:20 of the aforementioned example 1, and the mixture set to 95:5, 90:10, 70:30, 60:40, and 50:50 (five kinds) was produced. The closed mold alkaline batteries C1-C5 were produced like the above-mentioned example 1 except having used five kinds of this mixture as a positive active material. About each cell, the charge-and-discharge cycle examination of the same conditions as the previous experiment 1 was performed, and it asked for the ratio P of the service capacity of 9 cycle eye to the service capacity C1 of 9 cycle eye of each cell. This result is shown in Table 3. The result of a cell A1 is also shown in Table 3, and Q in Table 3 is the relative index which set the ratio P of the service capacity of 10 cycle eye to the service capacity C1 of 9 cycle eye of a cell A1 (89%) to 100. A cell with the larger value of Q has a better high-rate-discharge property.

[0039]

[Table 3]

電池	第 1 の活物質 (重量%)	第 2 の活物質 (重量%)	Q
C 1	9 5	5	8 5
C 2	9 0	1 0	9 8
A 1	8 0	2 0	1 0 0
C 3	7 0	3 0	1 0 0
C 4	6 0	4 0	9 9
C 5	5 0	5 0	電池重量減

[0040] As shown in Table 3, cells A1, C2-C4 have the large value of Q compared with a cell C1. After the charge and discharge of 3 cycle eye, since 50mg weight reduction arose, the cell C5 interrupted the examination. In order for a high-rate-discharge property to obtain the non-sintering nickel pole which gives a good closed mold alkaline battery from this result, it is good to use the active material which mixed nickel hydroxide (the 1st active material) and oxy-nickel hydroxide (the 2nd active material) by the weight ratios 90:10-60:40.

[0041] And also especially in this, service capacity serves as the maximum and the cells A1 and C3 using the active material which set the mixing ratio of the 1st active material and the 2nd active material to 80:20-70:30 by the weight ratio can be called optimal range.

[Experiment 4] In this experiment 4, in the 1st active material, the ratio in the cobalt atom conversion of oxy-cobalt hydroxide to nickel hydroxide was changed, and the relation with the service capacity of a cell was investigated. In addition, the ratio of the oxy-cobalt hydroxide to the oxy-nickel hydroxide in the 2nd active material is fixed to 5% of the weight by cobalt atom conversion. Moreover, the weight ratio of the 1st active material and the 2nd active material is fixed to 80:20.

[0042] The amount of the cobalt sulfate used at the time of producing the nickel hydroxide (the 1st active material) which covered oxy-cobalt hydroxide is replaced with 13.1g (equivalent to 5 % of the weight at cobalt atom conversion). 0.78g, 1.3g, 2.7g, 7.8g, 18.3g, 26.3g, 31.5g, and 39.4g (by cobalt atom conversion) In order, alkaline batteries D1-D8 were produced in order like the example 1 except having considered as 0.3 % of the weight, 0.5 % of the weight, 1.0 % of the weight, 3.0 % of the weight, 7.0 % of the weight, 10.0 % of the weight, 12.0 % of the weight, and 15.0 % of the weight. A detail is combined with the result of a cell A1, and is shown in Table 4.

[0043]

[Table 4]

電池	硫酸コバルト使用量 (g)	コバルト原子換算 (重量%)
D 1	0. 7 8	0. 3
D 2	1. 3	0. 5
D 3	2. 7	1. 0
D 4	7. 8	3. 0
A 1	1 3. 1	5. 0
D 5	1 8. 3	7. 0
D 6	2 6. 3	1 0. 0
D 7	3 1. 5	1 2. 0
D 8	3 9. 4	1 5. 0

[0044] About each above-mentioned cell, the charge-and-discharge cycle examination of the same conditions as the point was performed, and the service capacity C1 of 9 cycle eye of each cell was calculated. This result is shown in drawing 1.

[0045] As for a vertical axis, in drawing 1, a horizontal axis shows the ratio (% of the weight) in cobalt atom conversion of as opposed to nickel hydroxide for the service capacity of 9 cycle eye of oxy-cobalt hydroxide in the 1st active material, respectively. In addition, this vertical axis is expressed with the relative index which set service capacity of 9 cycle eye of a cell A1 to 100.

[0046] Drawing 1 shows that it is necessary to make the ratio in the cobalt atom conversion of oxy-cobalt hydroxide to



nickel hydroxide into 1.0 - 10.0 % of the weight in the 1st active material, in order to obtain the large non-sintering nickel pole of service capacity.

[Experiment 5] In this experiment 5, in the 2nd active material, the ratio in the cobalt atom conversion of oxy-cobalt hydroxide to oxy-nickel hydroxide was changed, and the relation with the service capacity of a cell was investigated. In addition, the ratio of the oxy-cobalt hydroxide to the nickel hydroxide in the 1st active material is fixed to 5% of the weight by cobalt atom conversion. Moreover, the weight ratio of the 1st active material and the 2nd active material is fixed to 80:20.

[0047] The amount of the cobalt sulfate used at the time of producing the oxy-nickel hydroxide (the 2nd active material) covered with oxy-cobalt hydroxide is replaced with 13.1g (equivalent to 5 % of the weight at cobalt atom conversion). 0.78g, 1.3g, 2.7g, 7.8g, 18.3g, 26.3g, 31.5g, and 39.4g (by cobalt atom conversion) In order, alkaline batteries E1-E8 were produced in order like the example 1 except having considered as 0.3 % of the weight, 0.5 % of the weight, 1.0 % of the weight, 3.0 % of the weight, 7.0 % of the weight, 10.0 % of the weight, 12.0 % of the weight, and 15.0 % of the weight. A detail is combined with the result of a cell A1, and is shown in Table 5.

[0048]

[Table 5]

電池	硫酸コバルト使用量 (g)	コバルト原子換算 (重量%)
E 1	0. 7 8	0. 3
E 2	1. 3	0. 5
E 3	2. 7	1. 0
E 4	7. 8	3. 0
A 1	1 3. 1	5. 0
E 5	1 8. 3	7. 0
E 6	2 6. 3	1 0. 0
E 7	3 1. 5	1 2. 0
E 8	3 9. 4	1 5. 0

[0049] About each above-mentioned cell, the charge-and-discharge cycle examination of the same conditions as the point was performed, and the service capacity C1 of 9 cycle eye of each cell was calculated. This result is shown in drawing 2.

[0050] As for a vertical axis, in drawing 2, a horizontal axis shows the ratio (% of the weight) in cobalt atom conversion of as opposed to oxy-nickel hydroxide for the service capacity of 9 cycle eye of oxy-cobalt hydroxide in the 2nd active material, respectively. In addition, the vertical axis of drawing 2 is expressed with the relative index which set service capacity of 9 cycle eye of a cell A1 to 100.

[0051] In order to obtain the large non-sintering nickel pole of service capacity, in the 2nd active material, it is more desirable than drawing 2 to make the ratio in the cobalt atom conversion of oxy-cobalt hydroxide to oxy-nickel hydroxide into 1.0 - 10.0 % of the weight.

[0052]

[Effect of the Invention] By this invention, the non-sintering nickel pole where the service capacity in a high rate discharge gives a large closed mold alkaline battery is offered.

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[Translation done.]